hylio

AgroDrone Spray System

AG-122

Operational History V2.2

Introduction

Hylio Inc. began developing UAS hardware and flight control software systems in 2015. In Fall 2017, Hylio received temporary regulatory approvals from the Costa Rican DGAC for BVLOS UAS package delivery in the Cartago and San Jose provinces. Hylio completed over 200 on-demand BVLOS parcel deliveries. During this period, Hylio gained valuable experience in advanced BVLOS and night time UAS operations.

As regulations constricted on package delivery in urban centers, Hylio transitioned to developing agricultural UAS. Hylio began crop treatment operations in the Fall of 2018 with permission from the El Salvadoran AAC. From Fall 2018 to Winter 2019 Hylio Inc. exclusively used the Agrodrone system and AgroSol software for all commercial UAS operations. The following two sections, “AgroDrone: Flight Pedigree” and “AgroDrone: Use Case History” outline the extent of these crop treatment UAS operations.

Hylio utilized this extensive operational experience to develop a product suite ideal for safe and reliable UAS spray operations. Uniquely positioned as both the end user and developer, Hylio was able to make extremely well-informed design choices. The final section in this manual “Systems Development Rationale” highlights the rationale behind certain design choices made during the development of the AgroDrone System.

AgroDrone: Flight Pedigree

The following chart highlights flight statistics for Hylio Inc.'s commercial operation of the Agrodrone system from **FALL 2018 to FALL 2020**. These values reflect paid commercial operations in El Salvador, Honduras, and Guatemala.

Flights	15000+
Flight Hours	3000+
Acres Serviced	50000+
Different Properties Serviced	3600+
Countries	El Salvador, Honduras, Guatemala

AgroDrone: Use Case History

The following chart highlights several of Hylio Inc.'s commercial use cases of the Agrodrone system from Fall 2018 to Fall 2020. Flight hours were not distributed evenly among these use cases. At least 40% of applications were different chemical treatments of sugar cane at various growth stages.

Crops	Sugar Cane, Corn, Rice, Plantains, Soybeans, Coffee, Okra, African Palm, Melon, Cucumber, Tomato, Pumpkin, Banana, Cotton, Peanuts
Chemicals (both contact & systemic)	ACETAMIPRID, BIFENTHRIN, ORGANOFOSFORADO, DIMETOATO, NITROXTEND 42% N, MONARCA 11.25 SE THIACLOPRID, EMAMECTIN BENZOATO, CLORFENAPYR, THIAMETOXAM, ENGEO 24.7 SC THIAMETOXAM, LAMBDACIALOTRINA, OMEX DP98, NATURFOS, ETHEPHONE, TRINEXAPAC-ETHYL, ROUND UP, INDAZIFLAM, ISOXAFLUTOLE
Speeds	6 – 23 mph (18 mph avg)
Spray Altitudes	3 – 20 ft AGL (10 ft AGL avg)
Operations	Night Ops (6pm-6am), Multi UAS (5/GCS), BVLOS (1 mile from GCS)

Systems Development Rationale

AgroSol

System	Rationale
Software Developed Internally	Hylio initially attempted running UAS operations with commercially available GCS software. It became evident that generic GCS software would not be sufficient for safe and efficient UAS operations. Hylio moved to develop a GCS platform, exclusively including features required for AgroDrone operation. This allowed pilot training time to reduce dramatically along with improved efficiency, control capabilities, and safety features.
Multi UAS Control	Hylio developed AgroSol from inception to be a multi-UAS GCS platform. AgroSol includes many features that allow safe multi UAS control and eliminate the risk of UAS/UAS collision.
Pause, Move, Land Control Through GCS Telemetry Link	AgroSol includes traditional flight control commands such as pause, move, and land which are typically relegated to RC. These commands allow pilots to have complete flight control without using the RC. Manual flight with an RC introduces human error. In order mitigate risk, Hylio took steps to reduce pilot RC use as much as possible.
Log Analyzer	Hylio employees initially performed weekly log audits on every drone to monitor for potential issues. After Hylio began completing hundreds of flights per day, this became unreasonable. A log analyzer was added to the back end of AgroSol to automatically monitor flight logs.
Obstacle Avoidance ON/OFF Switch	After Hylio implemented an obstacle avoidance system, the system was found to occasionally give false positives. When an obstacle is detected, the UAS stops and deviates from the flight plan without pilot direction in order to avoid a crash. Any time the UAS deviates from its predetermined flight plan, additional risk is introduced. When the system reports false positives, the system is exposed to unnecessary risk. Therefore, the user is allowed to turn off avoidance to avoid unnecessary risk when they determine a mission is safe enough to fly without obstacle avoidance.
Lost Link RTL ON/OFF Switch	Lost Link RTL functions in a similar manner to the obstacle avoidance system. When a lost link event occurs, the UAS will deviate from the flight plan to regain link. Sometimes, this introduces more risk than continuing the mission without C2 link. Therefore, the user is allowed to turn off this feature when they determine it would be safer for the UAS to follow its predetermined flight plan.

Emergency Motor Kill	AgroDrones are capable of cutting all motor power through a command from either the GCS or RC. This feature was included in AgroSol in order to improve pilot's ability to respond quickly to an emergency situation. The feature allows pilots to access the motor kill command even in the event of an RC failure.

Operational Procedures

System	**Rationale**
Limited RC Use	As highlighted in the AgroSol Rationale section, Hylio has made efforts to reduce pilot RC use wherever possible. The RC has been designated for emergency use only. Its primary function is to provide a communication link in the event of GCS signal loss, providing the pilot with a redundant method to send critical commands during an emergency situation. However, advanced users still have the option to use the RC for manual flight.
RC Flight Modes	RC flight modes are PosHold, RTL, and Land. In the event of a lost link situation where the pilot must take emergency action, they can activate the RC and select one of these 3 modes. PosHold allows the pilot standard manual flight control. RTL forces the UAS to autonomously return home to land. Land mode forces the drone to immediately autonomously land at its current location. RTL and Land flight modes allow a pilot who has lost CGS link to perform emergency maneuvers while the drone is BVLOS.
Focused on Safe Mission Planning	Hylio determined through operational analysis that the leading causes of incident using the AG-116 system occur during the mission planning phase. Because of this, Hylio's system emphasizes safe mission planning and system failsafe over relying on pilot skill.